PATENT ABSTRACTS OF JAPAN

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(54) SEPARATOR FOR FUEL CELL

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a separator for a fuel cell, particularly a solid polyelectrolyte fuel cell satisfying both current collecting performance and formability, and strength and corrosion resistance.

SOLUTION: The separator for the fuel cell is provided with a resin conductive layer 12 by mixing resin with conductive filler on at least one face of a metal substrate 11. It is characterized by that the resin conductive layer has at least a first resin layer 13 with volume resistivity of ≤1.0 Ωcm, and a second resin layer 14 forming a surface of the resin conductive layer and having volume resistivity smaller than the first resin layer.

FULL CONTENTS

[Claim(s)]

[Claim 1]A separator for fuel cells characterized by comprising the following which provided a resin electric conduction layer which mixed a conductive bulking agent with resin at least in one side of a metal substrate.
In said resin electric conduction layer, volume resistivity is the 1st resin layer of 1.0 or less ohm-cm.
The 2nd resin layer in which volume resistivity is [forming the surface of a resin electric conduction layer] smaller than said 1st resin layer.

[Claim 2]The separator for fuel cells according to claim 1 with which a volume fraction of a conductive bulking agent in said 2nd resin layer is characterized by being larger than a volume fraction of a conductive bulking agent in said 1st resin layer.
[Claim 3]The separator for fuel cells according to claim 1 or 2, wherein volume resistivity of said 2nd resin layer is 0.5 or less ohm-cm.
[Claim 4]The separator for fuel cells according to claim 2, wherein said 1st resin layer does 15-40 volume % content of a conductive bulking agent and said 2nd resin layer does 45-90 volume % content of a conductive bulking agent.
[Claim 5]The separator for fuel cells according to any one of claims 1 to 4 with which said resin electric conduction layer is characterized by having further the 3rd resin layer in which volume resistivity is smaller than said 1st resin layer in the interface side with said metal substrate.
[Claim 6]The separator for fuel cells according to claim 5 with which a volume fraction of a conductive bulking agent in said 3rd resin layer is characterized by being larger than a volume fraction of a conductive bulking agent in said 1st resin layer.
[Claim 7]The separator for fuel cells according to claim 5 or 6, wherein volume resistivity of said 3rd resin layer is 0.5 or less ohm-cm.
[Claim 8]The separator for fuel cells according to claim 6, wherein said 3rd resin layer does 45-90 volume % content of a conductive bulking agent.
[Claim 9]The separator for fuel cells according to any one of claims 1 to 8, wherein material of said metal substrate is chosen from a group which consists of stainless steel, titanium, an aluminium, copper, nickel, and steel.
[Claim 10]The separator for fuel cells according to any one of claims 1 to 9, wherein said conductive bulking

agent is chosen from a group which consists of a carbon system material, metallic carbide, a metal oxide, metal nitride, and metal.

[Claim 11]The separator for fuel cells according to any one of claims 1 to 9, wherein said conductive bulking agent is chosen from a group which consists of tungsten carbide, a carbon nanotube, and a carbon nano fiber.

[Claim 12]The separator for fuel cells according to claim 11 with which said carbon nanotube and/or a carbon nano fiber are characterized by a fiber diameter's being 0.001-0.5 micrometer, and fiber length being 1-100 micrometers.

[Claim 13]The fuel cell separator according to any one of claims 1 to 12, wherein said resin is chosen from a fluororesin and fluororubber.

[Claim 14]A separator for fuel cells given in a paragraph to either of the Claims 1-4 being a range whose thickness of said 1st resin layer is 5-300 micrometers, and a range whose thickness of said 2nd resin layer is 0.1-20 micrometers.

[Claim 15]A separator for fuel cells given in a paragraph to either of the Claims 5-8 being a range whose thickness of said 1st resin layer is 5-300 micrometers, a range whose thickness of said 2nd resin layer is 0.1-20 micrometers, and a range whose thickness of said 3rd resin layer is 0.1-20 micrometers.

[Detailed Description of the Invention]

[0001]

[Field of the Invention]This invention relates to the separator for fuel cells, and it is provided between the cells which adjoin in the fuel cell which laminates two or more cells and constitutes them in detail, A fuel gas flow route and an oxidizing gas pass are formed between electrodes, and it is a separator for fuel cells which separates heating gas and oxidizing gas, and is related with the separator for fuel cells excellent in especially moldability, hardness, and corrosion resistance.

[0002]

[Description of the Prior Art][the separator which constitutes a fuel cell, especially a polymer electrolyte fuel cell] In order to contact each electrode which pinches a solid-electrolyte membrane from both sides, to be arranged and to form distributed gas passes, such as heating gas and oxidant gas, between these electrodes, many projection parts for forming a gas stream way, a slot, etc. are formed in the field which counters the electrode of a separator.

[0003]The electromotive force of the cell of a fuel cell is as low as less than 1V, laminates two or more cells via a separator, and is usually constituted. Therefore, in order that a separator may play the role which contacts an electrode and derives electric current, the thing excellent in the current collection performance is required.

[0004]Conventionally, generally as a separator for fuel cells, it comprises metallic materials, such as hardness, precise carbon graphite excellent in conductivity or stainless steel (SUS), titanium, and an aluminium, as a substrate.

[0005]

[Problem to be solved by the invention]However, although high current collection performance is maintained

also by prolonged use highly [electrical conductivity] in the separator which comprises precise carbon graphite, Since it is a very weak material, there is a problem that it is not easy to machine cutting etc. that many projection parts and slots should be formed in the surface of a separator, and mass production is difficult.

[0006]On the other hand, in the separator which comprises an above-mentioned metallic material, since it excels in hardness and ductility as compared with precise carbon graphite, there is an advantage that press processing is possible for formation of many projection parts for forming a gas stream way, a slot, etc., and mass production is also easy. However, since it is exposed to the steam near the saturation at the temperature of 70-90 ** even if it is a polymer electrolyte fuel cell which operates at low temperature comparatively. [the separator using a metallic material] The contact resistance of the oxide film and electrode which the oxide film by corrosion tended to be generated by the surface, and were generated as a result becomes large, and there is a problem to which the current collection performance of a separator falls.

[0007]Then, the material which coated the surface of the metallic material which was excellent in workability as a component of a separator with noble-metals materials, such as gold excellent in corrosion resistance, is examined. However, since such a material is very expensive, there is a problem that flexibility is missing.

[0008]In order to solve these problems, these people indicated the separator which provided the resin layer which mixed the conductive filler on the surface of the metal substrate (JP,2002-15750,A). With this separator, while electrical conductivity is high and excellent in the current collection performance, it excels in moldability, hardness, and corrosion resistance.

[0009]This invention is made in order to raise performance further, and it is a thing.

The purpose is to provide the separator the fuel cell with which it is satisfied of moldability, hardness, and corrosion-resistant both, especially for solid polyelectrolyte type fuel cells.

[0010]

[Means for solving problem]This invention relates to the following matters.

[0011]Are separator for fuel cells which provided resin electric conduction layer which mixed conductive bulking agent with resin at least in one side of metal substrate, and, in said resin electric conduction layer, volume resistivity 1. 1st resin layer of 1.0 or less ohm-cm, The separator for fuel cells, wherein it forms the surface of a resin electric conduction layer and volume resistivity has the 2nd resin layer smaller than said 1st resin layer at least.

[0012]2. Separator for fuel cells of one above-mentioned description with which volume fraction of conductive bulking agent in said 2nd resin layer is characterized by being larger than volume fraction of conductive bulking agent in said 1st resin layer.

[0013]3. Separator for fuel cells given in the above 1 or 2, wherein volume resistivity of said 2nd resin layer is 0.5 or less ohm-cm.

[0014]4. Separator for fuel cells of two above-mentioned description, wherein said 1st resin layer does 15-40 volume % content of conductive bulking agent and said 2nd resin layer does 45-90 volume % content of conductive bulking agent.

[0015]5. Separator for fuel cells given in either of the above 1-4 to which said resin electric conduction layer is characterized by having further the 3rd resin layer in which volume resistivity is smaller than said 1st resin

layer in interface side with said metal substrate.
[0016]6. Separator for fuel cells of five above-mentioned description with which volume fraction of conductive bulking agent in said 3rd resin layer is characterized by being larger than volume fraction of conductive bulking agent in said 1st resin layer.
[0017]7. Separator for fuel cells given in the above 5 or 6, wherein volume resistivity of said 3rd resin layer is 0.5 or less ohm-cm.
[0018]8. Separator for fuel cells of six above-mentioned description, wherein said 3rd resin layer does 45-90 volume % content of conductive bulking agent.
[0019]9. Separator for fuel cells given in either of the above 1-8, wherein material of said metal substrate is chosen from group which consists of stainless steel, titanium, aluminium, copper, nickel, and steel.
[0020]10. The separator for fuel cells given in either of the above 1-9, wherein said conductive bulking agent is chosen from the group which consists of a carbon system material, metallic carbide, a metal oxide, metal nitride, and metal.
[0021]11. The separator for fuel cells given in either of the above 1-9, wherein said conductive bulking agent is chosen from the group which consists of tungsten carbide, a carbon nanotube, and a carbon nano fiber.
[0022]12. The separator for fuel cells of 11 above-mentioned description with which said carbon nanotube and/or a carbon nano fiber are characterized by a fiber diameter's being 0.001-0.5 micrometer, and fiber length being 1-100 micrometers.
[0023]13. A fuel cell separator given in either of the above 1-12, wherein said resin is chosen from a fluororesin and fluororubber.
[0024]14. The separator for fuel cells given in a paragraph to either of the above 1-4 being a range whose thickness of said 1st resin layer is 5-300 micrometers, and a range whose thickness of said 2nd resin layer is 0.1-20 micrometers.
[0025]15. The separator for fuel cells given in a paragraph to either of the above 5-8 being a range whose thickness of said 1st resin layer is 5-300 micrometers, a range whose thickness of said 2nd resin layer is 0.1-20 micrometers, and a range whose thickness of said 3rd resin layer is 0.1-20 micrometers.
[0026]
[Mode for carrying out the invention]Drawing 1 is the mimetic diagram which expanded near the separator of the laminated type fuel cell which laminated many cells. The cell 1a and the cell 1b, respectively The solid polymer electrolyte membrane 2a, 2b, While it has the electrodes 3a and 3b which pinch it and between the cell 1a and the cells 1b is separated with the separator 10, in contact with the electrode 3a, the gas stream way 4a is formed by the cell 1a side, and the gas stream way 4b is formed by the cell 1b side in contact with the electrode 3b. The separator 10 of this form formed the resin electric conduction layer 12 in both sides of the metal substrate 11, and since it is in contact with both the electrode 3a and the electrode 3b, it has connected the cell 1a and the cell 1b in series.
[0027]One example of the layer structure of a separator is shown in drawing 2. In the case where a separator is used for the cell of a termination, since a resin electric conduction layer may be provided only in one side of a metal substrate, only the layer structure of one side of a metal substrate is shown hereafter.
[0028]In the form of drawing 2, the resin electric conduction layer 12 provided in the surface of the metal substrate 11 consists of two-layer [of the 1st resin layer 13 and the 2nd resin layer 14]. The 2nd resin layer that forms the surface coat of a resin electric conduction layer has volume resistivity smaller than the 1st

resin layer. In this invention, since the 2nd resin layer that constitutes a surface coat is excellent in conductivity, as shown in drawing 1, resistance of a contact surface with the electrodes 3a and 3b can be made small. On the other hand, since the 1st resin layer provided in the metal substrate side is [volume resistivity] 1.0 or less ohm-cm, though sufficient conductivity is maintained, the conductivity like the resin layer of ** a 2nd is not required. Therefore, by for example making a resinous principle increase etc., moldability and ******, hardness, and corrosion resistance can be thought as important, and the 1st resin layer can constitute a layer. That is, volume resistivity can be changed between the 1st resin and the 2nd resin, and current collection performance, the moldability in press processing, hardness, and corrosion-resistant both can be satisfied to this invention by making the function of a resin electric conduction layer share with the 1st resin layer and the 2nd resin layer.

[0029]One example of the layer structure where separators differ is shown in drawing 3. This example is the structure which formed the 3rd resin layer 15 further between the 1st resin layer 13 and the metal substrate 11. The 3rd resin layer has volume resistivity smaller than the 1st resin layer, and can reduce the contact resistance between a metal substrate and a resin electric conduction layer. Namely, in this form, reduction of the contact resistance of the interface of a metal substrate and a resin electric conduction layer is aimed at by the 3rd resin layer, Reduction of contact resistance with an electrode can be aimed at by the 2nd resin layer, and the separator which is satisfied with on the other hand making the 1st resin layer into the lamination which thought as important moldability and ******, hardness, and corrosion resistance of current collection performance, moldability, hardness, and corrosion-resistant both can be obtained.

[0030]Even if the volume resistivity of the 3rd resin layer is equal to the volume resistivity of the 2nd resin layer, and it differs, neither is available for it.

[0031]Next, while the material of each layer is shown, it explains still in detail.

[0032]As a metal substrate used with the separator of this invention, the sheet metal which consists of stainless steel, titanium, an aluminium, copper, nickel, and steel can use it conveniently, and the range of thickness of 0.1 mm - 1.5 mm is desirable.

[0033]Surface treatment layers, such as an etching layer and a polishing layer, may be provided in the metal substrate surface in order to improve an adhesive property with a resin layer, and as for a surface treatment layer's thickness, 0.1-30 micrometers is desirable. Priming of the metal substrate surface may be carried out by a silane coupling agent etc.

[0034]The resin mixed by the resin electric conduction layer has chemical resistance to preferred fluororesin or fluororubber. Specifically PTFE (polytetrafluoroethylene), PFA (tetrafluoroethylene perfluoroalkyl vinyl ether copolymer), FEP (tetrafluoroethylene hexafluoropropylene copolymer), EPE (tetrafluoroethylene hexafluoropropylene perfluoroalkyl vinyl ether copolymer), ETFE (tetrafluoroethylene ethylenic copolymer), PCTFE (polychlorotrifluoroethylene resin), ECTFE (chlorotrifluoroethylene ethylenic copolymer), PVDF (polyvinylidene fluoride), PVF (polyvinyl fluoride), THV (tetrafluoroethylene hexafluoropropylene vinylidene fluoride copolymer), VDF-HFP (vinylidene- fluoride hexafluoropropylene copolymer), TFE-P (vinylidene-fluoride propylene copolymer), fluorine-containing silicone series rubber, fluorine-containing vinyl ether system rubber, fluorine-containing phosphazene system rubber, and a fluorine-containing thermoplastic elastomer can be mentioned. These fluororesins or fluororubber is independent, or can mix and use two or more sorts.

[0035]PVDF, THV, VDF-HFP, and TFE-P which contain vinylidene fluoride from a point of moldability

especially are preferred.

[0036]A conductive bulking agent has high conductivity, and what is excellent in corrosion resistance is preferred, for example, it can be used according to a service condition out of the powder of conductive materials, such as a carbon system material, metallic carbide, a metal oxide, metal nitride, and metal, or textiles.

[0037]As a carbon system material, as a powdered thing, graphite (artificial graphite, natural graphite), carbon black, and expanded graphite are mentioned, and a carbon nanotube, a carbon nano fiber, and carbon fiber can be mentioned as a fibrous thing. 0.001-0.5 micrometer of fiber diameters are 0.003-0.2 micrometer preferably, and a carbon nanotube and a carbon nano fiber have preferred fiber length from 1-100 micrometers and a desirable point conductive in 1-30 micrometers.

[0038]As metallic carbide, powder, such as tungsten carbide, silicon carbide, tantalum carbide, titanium carbide, niobium carbide, carbonization molybdenum, vanadium carbide, chromium carbide, and hafnium carbide, can be mentioned. Also in this, powder and textiles, such as tungsten carbide, titanium carbide, niobium carbide, and chromium carbide, are preferred.

[0039]As a metal oxide, powder, such as titanium oxide, ruthenium oxide, indium oxide, tin oxide, and zinc oxide, can be mentioned. Also in this, powder and textiles, such as tin oxide and indium oxide, are preferred.

[0040]As metal nitride, powder and textiles, such as chromium nitride, an aluminum nitride, molybdenum nitride, zirconium nitride, tantalum nitride, titanium nitride, gallium nitride, niobium nitride, vanadium nitride, and boron nitride, can be mentioned. Also in this, chromium nitride and molybdenum nitride are preferred.

[0041]As metal, powder, such as titanium, nickel, tin, copper, an aluminium, zinc, silver, a tantalum, and niobium, is mentioned as a powdered thing, and iron textiles, copper textiles, stainless steel textiles, etc. can be mentioned as textiles.

[0042]A conductive bulking agent may be used combining two or more sorts, using only one kind. For example, a carbon nanotube and/or a carbon nano fiber, and other carbon system materials can be mixed and used.

[0043]Also in the above conductive bulking agent, especially conductivity is high, even if exposed to the steam near saturation at the temperature which is 70-90 **, it is stable, and what has a few change of resistance is preferred, a carbon system material, metallic carbide, and metal nitride are preferred, and especially a carbon system material and metallic carbide are preferred. Combination with the mixture of either a carbon nanotube or a carbon nano fiber and its both, tungsten carbide, tungsten carbide, a carbon nanotube, and/or a carbon nano fiber is especially specifically preferred.

[0044]in the case of powder, 20 micrometers or less of weighted mean grain sizes [15 micrometers or less of] (measurement by laser dispersion) of a conductive bulking agent are usually 10 micrometers or less especially preferably preferably -- usually -- 0.01 micrometers or more of 0.05 micrometers or more are 0.1 micrometers or more especially preferably preferably. When fibrous, about a carbon nanotube and a carbon nano fiber, are as above-mentioned and. [at the time of the textiles of other materials] A fiber diameter is 20 micrometers or less preferably, and is usually not less than 5 micrometers preferably 1 micrometers or more 50 micrometers or less, and fiber length is preferred from 1-10,000 micrometers and a desirable point conductive in 5-1,000 micrometers.

[0045]The resin electric conduction layer of this invention mixes above-mentioned resin and conductive

bulking agent, In that case, the volume resistivity of the 1st resin layer that touches the metal substrate surface should just blend suitably so that it may become 1.0 or less (based on JIS K 7194) ohm-cm, What is necessary is just to blend suitably about the volume resistivity of the 2nd resin layer and the 3rd resin layer, so that volume low efficiency may become small from the 1st resin layer. 0.5 or less ohm-cm of volume resistivity of the 2nd resin layer and the 3rd resin layer are 0.1 or less ohm-cm especially preferably.

[0046]The volume fraction of the conductive bulking agent in the 2nd resin layer constitutes each layer from one mode of this invention so that it may become larger than the volume fraction of the conductive bulking agent in the 1st resin layer. Specifically, it is the content of the conductive bulking agent in the 1st resin layer 15 to 40 volume % (here, volume % is a volume ratio of the bulking agent to the volume of the whole resin layer.) Hereafter, it is the same. It is preferred to carry out and to make content of the conductive bulking agent in the 2nd resin layer into 45 - 90 volume %. Still more preferably, the content in the 1st resin layer is 15 to 35 volume %, and, on the other hand, the content in the 2nd resin is 60 to 90 volume %. If volume resistivity exceeds 1.0 ohm-cm by less than 15 volume % in many cases and the mixing ratio of a conductive bulking agent generally exceeds 90 volume %, shaping will become difficult easily.

[0047]Also about the 3rd resin layer, according to the 2nd resin layer, the kind of conductive bulking agent and quantity can be changed suitably (it may be the same as that of the 2nd resin layer), and can be decided suitably.

[0048]About the thickness of each resin layer, 5-300 micrometers of thickness of the 1st resin layer are usually 10-150 micrometers preferably first. 0.1-20 micrometers of thickness of the 2nd resin layer are usually 1-10 micrometers preferably.

[0049]When providing the 3rd resin layer, 0.1-20 micrometers of thickness of the 3rd resin layer are usually 1-10 micrometers preferably.

[0050]as for the thickness of the whole resin electric conduction layer, since a separator will become it thick that there are few anti-corrosion effects to a metal substrate, and they are too thick and the fuel cell by which the stack was carried out will become large if too thin, it is preferred to decide in the usual range of each of above-mentioned resin layers in consideration of conductivity and moldability, hardness, etc. Therefore, it is usually the range of 5.1-340 micrometers, and 11-170 micrometers is the range of 15-150 micrometers still more preferably preferably.

[0051]Although the manufacturing method in particular of the separator of this invention is not limited, for example The 1st resin layer, The 2nd resin layer and the 3rd resin layer are beforehand formed as a sheet by the usual extrusion, roll diffusion bonding, etc., respectively, and it laminates to one side or both sides of a metal substrate by the 3rd resin layer (when it exists), the 1st resin layer, and the 2nd resin layer, and unites with them by heat pressing processing. What is necessary is just to also perform the conditions of a heat pressing method in usual press condition, cooking temperature [of 120 ** - 300 **], and pressure $2.9x10^6$Pa - a $9.8x10^6$Pa ($30kgf/cm^2$-$100kgf/cm^2$) grade.

[0052]Especially, about the 2nd and 3rd resin layer, a lot of conductive bulking agents are contained, and since formation of the sheet of self holding nature may be difficult, then, a film can be beforehand formed on a suitable transfer base material, and it can laminate by carrying out hot printing of this. As a method of forming a film in a transfer base material, the solution which dissolved resin and a conductive bulking agent in the suitable solvent, for example is applied on a transfer base material, and the method of drying is mentioned.

[0053]Thus, after forming the layered product which provided the resin electric conduction layer in the metal substrate, the method of forming a projection part and a slot by press processing, and making it into the separator of predetermined shape is preferred from points, such as productivity.

[0054]

[Working example]Hereafter, although an embodiment is described, this invention is not limited to this.

[0055]<Embodiment 1> fluororesin ("Sumitomo 3M, Inc." make THV220G) specific gravity 2 23 weight section (70 volume %) and tungsten car bird (Product [made from an "Allied Material"] WC20 specific gravity 15.5) 77 weight section (30 volume %) were mixed with the biaxial extruder.

[0056]The 200-micrometer-thick fluororesin sheet (the 1st resin layer) was created for this mixture in extrusion.

[0057]A metal substrate uses what formed a 0.1-micrometer back-and-front polishing layer for the back-and-front side of SUS304 (0.3 mm in thickness) by the blast grinding method, After applying to both sides of SUS304 which carried out the surface polish layer of the 3% of silane coupling agent (two-stage-liquefaction8331 by "GE Toshiba Silicones Co., Ltd.") ethanol solution by bar coater ("MATSUO SANGYO #" 10 No.) as primer, 100 ** dried for 10 minutes and it laid in order of the conductive fluororesin sheet / SUS304/conductivity fluororesin sheet, and in pressure $3.5x10^6$Pa ($36kgf/cm^2$), heat pressing processing was carried out, lamination unification was carried out for the temperature of 200 **, and 10 minutes, and the 1st resin layer was fabricated to both sides of the metal substrate.

[0058]On the other hand, so that it may be set to MEK (methyl ethyl ketone) as an object for the 2nd resin layer formation and may become 10weight % as solid content, It mixed with the fluororesin ("Sumitomo 3M, Inc." make THV220G specific gravity 2) by the carbon nanotube ("Showa Denko K.K." make gaseous phase method carbon fiber <VGCF> specific gravity 2) volume ratios 30/70, and the coating material was produced.

[0059]The above-mentioned coating material was applied by bar coater ("MATSUO SANGYO #" 24 No.) on the base film (polyethylene terephthalate, the product made from Mitsubishi Chemical Polyester: 25 micrometers in thickness), the solvent was dried at 80 ** and the transfer sheet whose thickness of a transfer layer is 10 micrometers was obtained. After laying the resin side on top of the 1st resin layer of metal substrate both sides and carrying out heat pressing in pressure $3.5x10^6$Pa ($36kgf/cm^2$) for the temperature of 200 **, and 10 minutes, using the obtained transfer sheet two sheets, the transfer base material was stripped and the 2nd resin layer was formed.

[0060]The thickness of the obtained composite panel 1 was 0.72 mm.

[0061]So that a transfer base material (PET sheet) may change outside, [the fluororesin sheet (the 1st resin layer 200 micrometers in thickness) obtained by the same method as <Embodiment 2> embodiment 1, and two transfer sheets (transfer layer 10 micrometers in thickness)] After laying in order of the transfer sheet / fluororesin sheet / transfer sheet and carrying out heat pressing in pressure $3.5x10^6$Pa ($36kgf/cm^2$) for the temperature of 200 **, and 10 minutes, two transfer base materials were stripped and the 2nd and 3rd resin layers were formed in the both sides of the 1st resin layer. The total thickness of the obtained conductive liner sheet was 220 micrometers.

[0062][two conductive liner sheets obtained with the described method, and SUS304 board (0.3 mm in thickness) with which the same surface treatment as Embodiment 1 was performed] laying in order of a

conductive liner sheet / SUS304 board / conductive liner sheet, carrying out heat pressing in pressure $3.5x10^6$Pa ($36kgf/cm^2$), and carrying out lamination unification for the temperature of 200 **, and 10 minutes -- both sides of a metal substrate -- [the outside to 2nd / the / resin layer/] -- the resin layer / the 3rd resin layer of one were formed.

[0063]The thickness of the obtained composite panel 2 was 0.74 mm.

[0064]The shape of the gas stream way after a press is a waveform about the composite panel 1 and the composite panel 2 which were obtained in <result of press processing> above-mentioned embodiments 1 and 2, The pitch of a gas stream way uses the metal pattern which can be fabricated to 0.5 mm, and the difference of 3 mm, a wave-like convex part, and a crevice is a product made from a press briquetting machine "Amada Co., Ltd.". Torque pack press Press forming was carried out at the room temperature in pressing speed 45spm.

[0065]The obtained separator for fuel cells had the good adhesive property of the fluororesin layer and metal plate containing tungsten carbide or a carbon nanotube, and there was no exfoliation.

[0066]The contact resistance of the composite panels 1 and 2 obtained in <measurement of contact resistance> embodiments 1 and 2 was measured. Evaluation of contact resistance was performed as follows.

1. Measuring apparatus ohm-meter : YMR-3 type (made by Yamasaki Energy machine research institute company)

Load apparatus: YSR-8 type (made by the Yamasaki Energy machine research institute company)

Electrode: Two plates made from brass (an area of one square inch, mirror plane finishing)

2. measurement condition method: -- 4 terminal method impression electric current: -- 10 mA (exchange, 287 Hz)

接触荷重：0．９０×１０^{5}Ｐａ
１．８×１０^{5}Ｐａ
４．５×１０^{5}Ｐａ
９．０×１０^{5}Ｐａ
１８×１０^{5}Ｐａ

Open-end child voltage: Below a 20-mV peak

Carbon paper: TGP-H-090 (0.28 mm in thickness) by Toray Industries, Inc.

3. Having inserted the separator 23 with the electrode 21 made from brass from both sides via the carbon paper 22, and adding predetermined load with the measuring apparatus shown in measuring method drawing 4, the voltage at the time of predetermined electric current impression was measured by 4 terminal method, and it asked for contact resistance.

[0067]The composite panels 1 and 2 in the graph of drawing 5 showed the test result. The resin impregnating graphite G347B by Tokai Carbon Co., Ltd. was also evaluated for comparison.

[0068]the contact resistance value boiled the composite panels 1 and 2 markedly, was small, and they were contact resistance values almost equivalent to resin impregnating graphite as shown in the graph of drawing 5.

[0069]

[Effect of the Invention]According to this invention, the separator the fuel cell with which it is satisfied of current collection performance, moldability, hardness, and corrosion-resistant both, especially for solid

polyelectrolyte type fuel cells can be provided. Therefore, the availability as an object for fuel cells in which prolonged operation is possible is large.

[Brief Description of the Drawings]

[Drawing 1]It is a figure showing near the separator of a fuel cell typically.

[Drawing 2]It is a figure showing one example of the layer structure of the separator of this invention.

[Drawing 3]It is a figure showing one example of the layer structure of the separator of this invention.

[Drawing 4]It is a figure showing the measuring method of contact resistance.

[Drawing 5]It is a graph in which contact load and the relation of a contact resistance value are shown.

[Explanations of letters or numerals]

1a and 1b Cell

2a and 2b Solid polymer electrolyte membrane

3a and 3b Electrode

4a, 4b gas stream way

10 Separator

11 Metal substrate

12 Resin electric conduction layer

13 1st resin layer

14 2nd resin layer

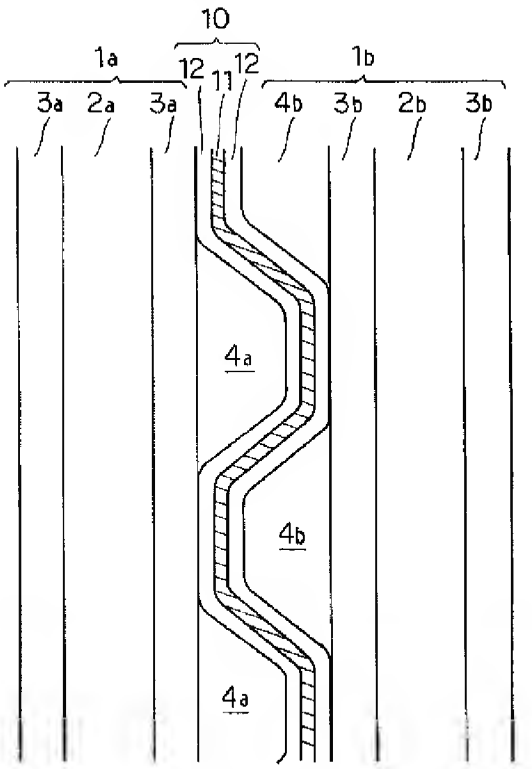
15 3rd resin layer

21 Electrode made from brass

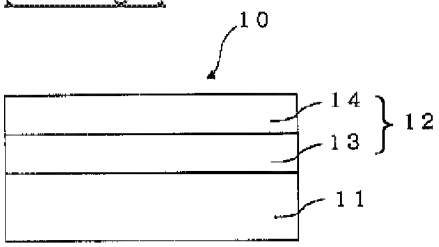
22 Carbon paper

23 Separator

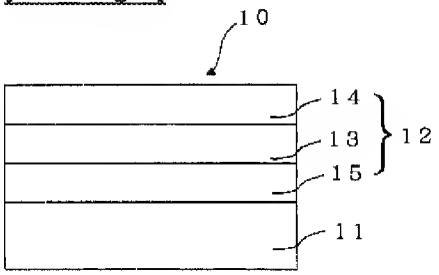
[Drawing 1]



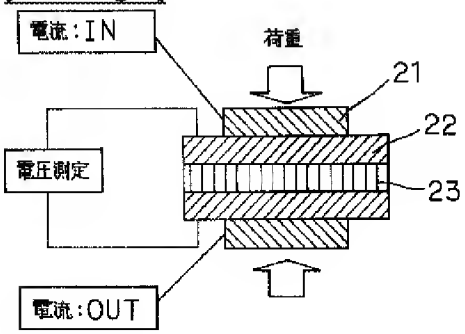
[Drawing 2]



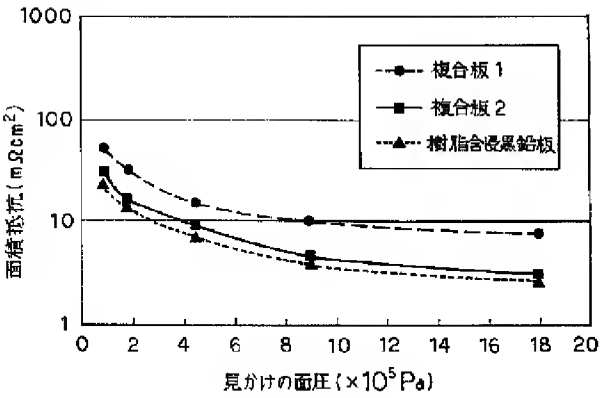
[Drawing 3]



[Drawing 4]



[Drawing 5]



[Translation done.]